RESEARCH INFRASTRUCTURE IMPROVEMENT (RII 4)
PROPOSAL DEVELOPMENT PROCESS

EDUCATION & OUTREACH WHITE PAPER

FOR DISCUSSION
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TITLE: INCREASING NEW MEXICO'S STEM PIPELINE: IMPROVING K-12 STEM CLASSROOM EDUCATION THROUGH EXPERIMENTAL LEARNING WITH FOCUS ON EPSCOR RESEARCH NEXUS – ENERGY, WATER, AND THE ENVIRONMENT

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Increasing New Mexico's STEM Pipeline: Improving K-12 STEM Classroom Education through Experiential Learning with Focus on EPSCoR Research Nexus: Energy, Water, and the Environment

Description of Efforts:

We propose strengthening New Mexico's STEM Pipeline by improving K-12 STEM education in the classroom. A focused statewide collaborative of formal and informal education professionals, research scientists, and university students will create resources and provide teacher professional development focused on the nexus of water, energy and the environment. The four components interwoven in this proposal are resources, teacher professional development, near-peer mentoring, and symposia. The specific goals are to improve classroom instruction and prepare students for further learning and careers at the nexus of water, energy and environment through experiential learning, computational thinking, and exposure to research on the EPSCoR Research nexus. Outdoor spaces close to schools will be utilized as resources for student learning.

Science Classroom Materials/Resources: To enhance students' experiential learning about energy, water, and the environment, research scientists, university students, university education outreach and informal education program staff will develop modules, and other curricula/resources, aligned with New Mexico Standards-and-Benchmarks, to be used in K-12 classrooms and other venues. Scientific equipment/materials are critical resources for teachers to implement experiential learning. Workshops will support teachers' practice of both curricula and materials.

To engage students using cyber-infrastructure tools/ techniques, Project GUTS and Supercomputing Challenge personnel will create computational modeling and data analysis resources and units aligned with the CSTA K-12 Computer Science Standards to be used in K-12 classrooms and other venues.

Teacher professional development: Educators will participate in workshops, learning science content and practice to effectively implement experiential learning and computational modeling activities with their students.

Summer institutes for K-12 teachers will be held at various locations throughout the state each year. They will focus on NM EPSCoR Nexus topics: energy, water, and the environment as relates to New Mexico. Sites and partners include Scientifically Connected Communities and NM Water Resources Research at NMSU, UNM, Bioregional Outdoor Education Project, Project GUTS at the Santa Fe Institute, Supercomputing Challenge, Environmental Education Association of New Mexico, and others. The goals of these institutes will be to increase teachers' scientific content knowledge and experiential teaching skills, discuss current scientific research, and to develop collaborative relationships between scientists and teachers to engage students in research combining fieldwork (experiential learning and use of school outdoor spaces) and cyber-tools (computational modeling and data analysis).

One-day teacher and teacher/student mini-workshops will be held throughout the school year to: a) expand upon previous professional development events as teachers increase scientific knowledge, skills, and information about current research; b) provide a venue for teachers, scientists, university students and high school students to share their research projects; and c) develop forums for public events at museums and other community sites.

Teacher mentoring: Throughout the school year, outreach mentors will meet with teachers monthly to coordinate teacher-scientist-university student partnerships and support teachers in incorporating their new knowledge and skills into their curriculum thus transforming their teaching method.

Student Mentor Corps: Undergraduate and graduate students will serve as mentors to high school students to help them design and conduct experiments then analyze data relating to EPSCoR Nexus topics.

Near-peer mentoring will be achieved through integrating UG and Grad students in summer programs and through establishing collaborations between high school and university faculty to design courses that promote university students' participation as mentors to HS students in specific science courses.

Outreach: To attract and engage more mid/high schools, research scientists and students will present their research during roundtables both on higher education campuses in addition to taking their presentations to middle and high school science classes. Mid/High students will participate in these roundtables, conducting experiments designed and facilitated by UG and graduates who are

knowledgeable and enthusiastic about their research. University and HS students will participate in middle school family science nights.

EPSCoR Symposiums: As science researchers, university and high school students will develop projects with scientist guidance around the Energy, Water, and Environment Nexus. Symposiums will be held at various locations around the state to share their data. Presentations will be made in middle/high school science classrooms to share projects with thousands of New Mexico students.

Target Audience: K-12 educators and students, research scientists, undergraduate/graduate university faculty and students, and informal science educators

Rationale: One major recommendation of the report, *Rising Above the Gathering Storm Two Years Later: Accelerating Progress Toward a Brighter Economic Future,* is to "upgrade the skills of existing teachers" (2010). A study done on education reform by Marsh et al., (2005), states the conclusion that to improve student education, there must be "strong support and professional development for teachers". Another study by Vivien Stewart indicates "that many countries seeking to prepare their students with the complex, higher-order cognitive skills that economy demands, the major focus is strengthening the quality and effectiveness of the teacher workforce" (2009). The Education Trust of the Center for Public Education reports that "one-third of high-performing schools spent 10% of their Title I budgets on teacher professional development" (2005). Place-based pedagogy encompasses experiential inquiry learning in places (often in the outdoors or in the local community); trans-disciplinary and cross-cultural synthesis of scientific and humanistic subjects in the context of place; and if possible, contributions to local ecological & cultural sustainability through service-learning (Woodhouse & Knapp, 2000; Semken, 2005; Gruenewald & Smith, 2008).

Relevance to Energy, Water, and Environment Nexus: The collaboration of K-12 teachers, science researchers, undergraduate and graduate students, various outreach programs, and university faculty will focus on the Nexus of Energy, Water, and Environment. Students will learn about research being conducted in New Mexico and develop their own research projects. There will be a New Mexico context for science education, making it relevant to students. Local and regional cultural context will be an integral component of programs.

The caliber of research scientists and university students working in New Mexico should be celebrated and showcased. Our citizens should be fully informed about current findings about energy, water, and the environment. As students engage at an early age in scientific research, their understanding will increase. The best way to disseminate this information to the general population is through young people and their families. Teachers empower students with the knowledge they need to make good decisions as adults. As teachers are supported to encourage students to explore how Energy, Water, and Environment intersect and the problems facing New Mexico, present research possibilities, and find solutions, our world will become a better place.

Science educators have to be comfortable with the processes of scientific inquiry and research. Professional development that provides educators the scientific knowledge they need, and the tools to provide an experiential learning environment in their classrooms, including research, will support them to make profound changes in their classrooms. Students desire real work. Energy, Water and the Environment are all interrelated and it is vital for our society and economy for future citizens to understand changes in our actions will result in positive changes for our world. If educators are not comfortable with subjects, they are not included in their curriculum. Continued support and contact with educational specialists, research scientists, and student mentors after professional development is essential to continue the work done in the classroom. Reinforcement and resources should be available to do the activities as educators transform their teaching methods to increase student involvement in STEM fields.

Cost-Share: All of the participating organizations have funding in addition to EPSCoR grants. These existing programs' resources, structures, and staff will be leveraged to have a greater impact on science classroom education than can be accomplished individually.

Evaluation: Several methods will be utilized to evaluate the outcomes. As state-wide collaboration projects are developed, an evaluator will be essential to assess: teachers' scientific knowledge and experiential teaching methods; percentage of increased experiential learning in participating teachers' classrooms; the number and quality of student research projects; and documenting how many middle/high school students who participate in research projects enroll in STEM-related fields after graduation.